[PROC. ROY. SOC. VICTORIA, 32 (N.S.), PT. II., 1920].

ART. XIX.—*On the Structure of a New Species of Earthworm from South Australia, Megascolex fletcheri.*

BY JEAN H. SHANNON, B.Sc.

(Communicated by Professor Sir Baldwin Spencer).

[Read December 11th, 1919].

(With Plates XXVII.-XXXI.)

Up to the present time, though a large number of species of earthworms has been described from Australia, more especially by Dr. Michaelsen,[1] from South-West Australia, Prof. Spencer,[2] and Mr. J. J. Fletcher,[3] from New South Wales, Victoria, Queensland and Tasmania, there has, as yet, been published only one more or less complete detailed account of one type of Australian earthworm—Megascolides australis. The species now described represents another type, differing in important respects from Megascolides, and, on the suggestion of Professor Sir Baldwin Spencer, I have attempted to describe its structure as completely as possible. The work has been carried on in the Zoological Department of the Melbourne University.

I have followed the classification suggested by Michaelsen.[4] The species evidently belongs to the genus Megascolex, as defined by him, and I propose for it the name of *Megascolex fletcheri*, the specific name having reference to the first naturalist who made a study of Australian earthworms.

Habit.

The material dealt with in this paper was collected in South Australia at a spot about ten miles due east from Kapunda, the latter being a town situated in an agricultural district.

---

1. Michaelsen.—"Die Fauna Südwest-Australiens," erster Band, 1907-1908, pp, 117-232.

2. Spencer.—"The Anatomy of Megascolides australis." Trans. Roy. Soc. Vic., Vol. I., Part I., 1882. "Preliminary Notice of Tasmanian Earthworm," op. cit. 1894.

3. Fletcher.—A series of six papers, the first of which, "Notes on Australian Earthworms, Part I.," was published in Proc. Linn. Soc., Vol. I., Series 2, 1886, p. 523. The remaining five were published in the same Proceedings in 1886, 1887, 1889, respectively.

4. Michaelsen.—op. cit. p. 160.

The type of country is gently undulating, and mostly very rich clayey soil. The timbered land is isolated now, owing to cultivation.

The climate is moderate, with occasional very dry seasons, and generally a long summer with high temperatures.

These particular earthworms seem to be very peculiar and restricted in their habitat. Quite a large area of scrub land was very carefully searched, and only two small spots were found to shelter the worms. One was a somewhat low-lying, damp place beside a dam, and the other a more or less elevated spot, less timbered and sunny. In both cases the earth worms were concealed underneath cut timber for fence posts, and during the wet winter of last year were very plentiful.

Their habits were essentially moisture loving, and in the damp earth, and even in the actual timber distinct, and large holes or burrows were made, down which the worms rapidly disappeared when the post was overturned. A considerable amount of slimy, glassy material was found wherever the worms had passed, and the earth all about their burrows was well worked and divided. In some cases only a furrow was made in the earth, the lower surface of the post serving to roof it in.

When the specimens were dropped into spirit for preservation, they definitely contracted, and, as is usual with earthworms, put out a large quantity of slimy fluid through the dorsal pores all along the body.

External Anatomy.

The freshly collected worms are of a pale pink colour, and vary somewhat in size, but as a rule are from ten to twelve inches in length, and between one quarter and a-half an inch in diameter.

The clitellum is very distinct in the mature animals, and is of a paler shade than the rest of the body. It is situated about an inch from the anterior end, and is not quite regularly cylindrical, being pinched in on the ventral surface. It extends from just after the eleventh segment to the end of the eighteenth. The surface of the worm appears to be covered by a translucent and very thin membrane, but in the spirit specimens the glassy appearance is lost to a large extent, and the membrane becomes rather more conspicuous and tougher, but looses its iridescence.

There is a ring of stetae in the middle of each segment, broken at the mid-dorsal and mid-ventral lines. The most median pair on the ventral surface on each side are somewhat larger than the rest.

The segments themselves are quite distinctly marked, especially in the spirit specimens. There is a distinct median furrow around each segment, and towards the anterior end of the worm two smaller furrows may generally be found, one on either side of the main furrow.

The prostomium is normally very nearly completely dove-tailed into the peristominum.

The openings to the exterior of the dorsal pores and of the reproductive organs are mostly quite distinct, and can be seen with the naked eye.

On the dorsal surface the only openings that occur are the dorsal pores. These are situated between the successive segments in the median line, the first being between segments four and five.

On the ventral surface the most conspicuous openings are those of the vasa deferentia, on the eighteenth segment. Each is surrounded by two swollen somewhat semi-circular lips, is situated away from the median line between the third and fourth pairs of setae, and is not included in the clitellar region. (Plate XXVIII. Fig. 1. ♂) (Plate XXVII. Fig. 1. ♂).

On the fourteenth segment ventrally is a single median raised oval area, and in the centre of this is the opening of the common duct formed by the union of the right and left oviducts. (Plates XXVII and XXVII., Fig. 1 ♂).

Between segments six and seven, seven and eight, and eight and nine, are the three pairs of spermathecal pores, opening ventrally. It is very difficult to decide whether they open in line with the fourth or the fifth seta.

In one fresh specimen that I examined there seemed to be an indication of two smaller openings, on either side of the main pore. Subsequent dissection showed the presence of accessory glands in this region in all instances.

Besides these more conspicuous openings there are certain small glands associated with the spermiducal gland, and communicating with the exterior on the ventral surface between segments sixteen and seventeen, nineteen and twenty, twenty and twenty-one, and twenty-one and twenty-two.

Internal Anatomy.

Alimentary Canal.—The living worm has very marked power of evaginating the whole crop to the extent very often of one-quarter of an inch. Upon opening up the worm one finds that the front end of the gizzard is invaginated, and appears almost urn-shaped, until the front end is pulled out, when it becomes oval.

The posterior end of the gizzard is between segments six and seven, and all the septa up to this region are considerably displaced, forming angles of about 22.5° with the body wall.

The anterior end of the gizzard is very changeable, according to the amount of evagination it has undergone.

Following on from the gizzard is a long, almost straight intestine running the length of the body, and opening to the exterior at the posterior end. It presents a bulbous expansion in each segment along its length. (Plate XXVII. Fig. 2.)

Nervous System.

There is a distinct nerve collar around the oesophageal region in segment two, with a conspicuously swollen dorsal portion slightly pinched in at the median line. On either side of the collar is given off a large nerve, which runs forwards to supply the anterior part of the oesophagus. A smaller branch supplies the crop behind on each side. After the union of the nerve ring ventrally, the fibres are collected into a very conspicuous cord, which is slightly swollen in each segment. A transverse section of the cord reveals the rather a-typical fact that there is only one large giant fibre present. (Plate XXVII. Fig 3.) (Plate XXX. Fig. 2.)

Nephridial System.

From dissection there does not appear to be a nephridial system other than very numerous micronephridia forming a fringed ring around each segment, especially towards the posterior end.

Microscopic examination of longitudinal sections taken from about the last third of the worm, reveals very peculiar structures, possibly represent a special form of nephridial organ. They are perfectly regular in position, and segmentally arranged. Each is somewhat club-shaped, and attached to the wall of the coelome by a thin stalk. Even under the very high powered objective, there appears to be little structure. The stalk is made up of almost a single chain of nucleated cells, which gradually merge into those of the outer peritoneum. They appear to have no duct, and no passage is visible from them through the muscle layers to the exterior.

The head portion of the structure has different forms, sometimes being long and regular, with a covering of small nucleated cells, and an internal longitudinal clear region, that may, perhaps, indicate the presence of a minute duct. Along the latter at intervals are rounded patches of very numerous and clearly nucleated cells. The rest of the structure seems to be almost non-cellular. Sometimes the base of the "head" is distinctly broadened, and a number of parallel ducts appear to traverse it. In yet other cases the central duct seems to follow a spiral course. In one instance the end of the structure appeared to bend towards an opening through the septum, thus seeming to indicate a relationship to the successive segments typical of meganephridia. (Plate XXIX. Fig. 4.)

The supposition that these organs are connected with the excretary function is further borne out by the development as seen in very young specimens. At an early stage the whole structure is hardly more than a chain of cells, with large nuclei, and at intervals clusters of even more regular and oblong cells. An arrangement that suggests the nephridial structure in some species of Megascolides figured by Beddard, page 51, fig. 13.

The marked similarities between this worm and certain of the Megascolides types again strengthens the idea that the mega nephridia which are generally well developed in the latter genus are represented in this animal by the peculiar structures described above. Besides this, the position of the organs at the posterior end, their segmental arrangement, and their structure also bears out the theory as to their function.

Blood Vascular System.

This system is very difficult to study, except in freshly killed specimens. Extending along the mid-dorsal line of the main length of the body is a large thin-walled dorsal vessel. Smaller lateral vessels are given off on each side in segments five, two and nine.

Just ventral to this vessel is a much smaller median one, extending between segments eight and fourteen.

A large thin-walled pair of hearts spring from either side of this vessel by a very small connection in segments ten, eleven, twelve and thirteen. A very fine pair of vessels also spring from this longitudinal vessel in each segment just anterior to the hearts, and probably are present in segments eight, nine and fourteen as well. (Plate XXVII. Fig. 2.)

There seems to be only a single median ventral vessel into which open the large hearts, but just before doing so each heart gives off a very fine vessel from the outer side, supplying the body wall. Microscopic examination of this ventral blood vessel in transverse section showed that the thickness and structure of the walls were quite peculiar. (Plate XXX. Fig. 4.)

There is a quite definite endothelial lining, with large nucleated cells, and a wall that seems to be largely composed of 'muscular fibres, running mainly in a circular direction. Besides these elements there are numerous very large clear nucleated cells in the walls of the vessel, and here and there between these latter are quite conspicuous spaces or holes.

Reproductive System.

Female Organs.—The paired ovaries are situated in the thirteenth segment and the two oviducts have very large funnel-shaped openings just below them. The ducts pass through the septum, dividing segments thirteen and fourteen, and then pass to the mid-ventral line, and unite as they pass through the thick muscular wall to open to the exterior. The interior of each oviduct and of the common duct is richly supplied with long cilia, the length of which seems to be about equal to the radius of the passage. (Plate XXVII. Fig. 3.) (Plate XXX. Figs. 1, 2, 3.)

Male Organs.—There are two pairs of testes, one in each of segments ten and eleven. These are peculiarly small, even in a well-matured specimen. The vasa deferentia correspond in number with the testes, and open by very conspicuous and much folded rosettes just below the testes, and then continue quite separately and slightly embedded in the ventral muscles of the body wall to the eighteenth segment. Here, still paired, they enter the muscular wall of the duct from the spermiducal gland of their own side, about the middle of its length, and run parallel with the lumen for some little distance before they enter separately.

The structure and relation of these separate vasa deferentia recalls that of the same parts in Megascolides australis. (Plate XXVII. Fig. 3.) (Plate XXXI. Figs, 1, 2, 3.) Plate XXVIII. Figs. 5, 9.)

The spermathecae are paired and situated in the seventh, eighth and ninth segments, decreasing in size from behind forwards. Each consists of an oval sac, with an equally long but finger-like diverticulum, arising from just below the junction of the base of the sac with its stalk. In the most mature worms this process often appeared to have become lobed at the tip. (Plate XXVIII.

Fig. 3.) The spermathecal sac and its diverticulum open to the exterior by a large duct through the stalk. In the last region this passage seems to be furrowed transversely. (Plate XXIX. Fig 1.)

Associated with the spermathecae are other paired glandular structures. In the sixth segment is found the first pair one on each side. The seventh and eigth each contain two pairs and in the ninth is again a single pair. Ducts from these glands open on either side of the ducts from the spermathecae—i.e., between segments six and seven, seven and eight, and eight and nine. (Plate XXVII. Fig. 3.) (Plate XXVIII. Fig. 2.) (Plate XXIX. Fig. 1.)

The minute structure of these glands is very difficult to determine. Each is decidedly floccular in nature, and the surface cells are large, nucleated, and more or less regular. Internally the cells become less granular, smaller and very irregular, but some still possess very large nuclei, converging to the base of the structure there appears to be clear channel-like spaces between the cells, and these open to the interior of the "stalk." There is no definite duct running from the cell mass, but the whole of the stalk appears to become split longitudinally in an irregular and complex manner. Finally we get a widening of the passage to form a very conspicuous flask-like opening to the exterior. The surrounding epidermal cells become greatly elongated and bow-shaped to surround this structure. In most cases the cuticle is not ruptured, and this seems to show that an opening is formed only at intervals, as the duct becomes full of secretion. Plate III., Figs. 2, 3.)

The vesiculae seminales are large, and occupy most of segments eleven and twelve.

In the eighteenth segment lying tranversely are found two very large organs, the spermiducal glands. Each is flattened dorsoventrally, and is an elongated oval shape. Passing from the inner end of each is a very stout duct, which is practically coiled upon itself on its way to the exterior. The vasa deferentia enter this duct separately about mid-way along its upper surface. The prostate itself seems to be made up of lobes in close apposition to one another.

Microscopic examination shows little definite structure other than the clusters of cells in a less dense matrix, and transverse sections reveal the fact that the whole gland is traversed by one large duct lined by conspicuously nucleated and very regular cells.

In segments seventeen, nineteen, twenty, twenty-one and twenty-two, there are additional glandular structures associated with which are even smaller glands. The detailed structure of these masses of cells is difficult to determine, but apparently each consists of a large number of very granulated, irregularly-shaped and large cells, collected together. Here and there are smaller and non-granular cells arranged in groups.

There does not appear to be a definite duct, but passing from the grandular swelling are numerous small darker cells arranged in clusters, and these follow a disjointed passage through the thick muscular wall.

Problematic Gland in the Thirteenth Segment.

Still another peculiar structure is to be found from dissection, although no indication of its presence is given upon external examination. Attached to the anterior septum of segment thirteen, somewhat ventrally, is a pair of club-shaped organs, each slightly smaller than the smallest spermathecea.

In the less matured specimens examined there were three pairs of these glands—one in each of segments thirteen, twelve and eleven.

At this early stage there is practically no development of the reproductive system, and this fact seems to render it difficult to state definitely, whether these organs are or are not connected with reproduction, From longitudinal and transverse sections of the whole structure there appears to be no definite duct. The most striking features about the organ is the very abundant blood supply, the presence of definitely radiating groups of elements, and the occurrence of numerous spaces in the interior.

Beyond these points, there seems to be little else to notice, and it is difficult to suggest what is the function of these organs.

In conclusion, I wish to thank both Professor Sir Baldwin Spencer and Doctor Georgina Sweet for their valuable assistance and many helpful suggestions during the progress of my work.

EXPLANATION OF REFERENCE LETTERS.

Acc. Glds. - - - -	Accessory glands.
Acc. Op. - - - -	Opening of accessory glands.
Bld. - - - - -	Blood.
B.V. - - - - -	Blood vessel.
B.W. - - - - -	Body wall.

C.	Cuticle.
C. & C_2	Cell and Cell$_2$.
Clit.	Clitellum.
C.M.	Circular muscle.
C. Op. O.D.	Common opening of oviduct.
C. Ovd.	Common oviduct.
Cr.	Crop.
D.	Duct.
D.B.V.	Dorsal blood vessel.
Div.	Diverticulum.
D. of Sp.	Duct of spermiducal gland.
D.P.	Dorsal pore.
E.	Epidermis.
F.G.	Opening to oviduct.
G.	Giant fibre.
G.C.	Granular cell.
Gb.	Goblet, or slime cell.
Gld.	Gland.
Gz.	Gizzard.
H.	Heart.
I.	Intestine.
Inv.	Invaginated gizzard.
K.	Nucleus.
L.M.	Longitudinal muscle.
M.	Tissue supporting V.B. vessel.
N.	Nerve cord.
N.C.	Nerve collar.
Op.	Opening.
Op. Gld.	Opening of gland.
Op. Ovd.	Opening of oviduct.
Op. P.	Opening of spermiducal gland
Op. S.	Opening of spermatheca.
Ov.	Ovary.
Ovd.	Oviduct.
P.	Peritoneal cells.
Peri	Peristomium.
P. Gld.	Problematic gland.
Pr.	Spermiducal gland.
Pro.	Prostomium.
Ps.	Tissue supporting nerve cord.
Px.	Smaller less granular cells.

R.	Rosettes of vasa deferentia.
Rng.	Median furrow in segment.
Rs.	Large nucleated cells on surface of possible nephridial organs.
S.	Setae.
Sac.	Sac of spermatheca.
S.C.	Spinal cord.
Sept.	Septum.
Sg.	Large granular cell.
Sk.	Sickle-shaped cells.
Spth.	Spermatheca.
Spth. Op.	Opening of spermatheca.
St.	Stalk part of gland.
T.	Testes.
Vas. D.	Vasa deferentia.
V.B.V.	Ventral blood vessel.
V.D. op. P.D.	Vas deferens opening into duct from spermiducal gland.
V.D.	Vas deferens.
V. Sem.	Vesicula seminalis.
X.H.P.	Position of region shown in Fig 4, under the high powered objective.
X.S.	Radiating cells.
X.T.	Glandular structure on segment nine (as found in one specimen examined).
Y.	Apparent duct.
Y.C.	Space between cells.
Y.N.	Possible opening of supposed nephridal structure into adjacent segment.
Y.Z.	Interior of stalk from accessory gland in segment six, splitting to form apparent duct.

EXPLANATION OF PLATES.

PLATE XXVII.

Fig. 1.—Anterior end of earthworm, to show external features (diagramatic).

Fig. 2.—Diagram of anterior end of worm, to show alimentary canal and dorsal blood vessels.

Fig. 3.—Diagram of anterior end of worm, to show reproductive organs, nervous system, and accessory glands.

PLATE XXVIII.

Fig. 1.—Anterior end of worm, ventral view, to show main external features.

Fig. 2.—Diagram of longitudinal section through region of spermathecae.

Fig. 3.—Types of spermathecae.

Fig. 4.—Diagram of segment thirteen, to show relative position of associated parts.

Fig. 5.—Sketch of spermiducal gland of right side, to show general features.

Fig. 6.—Drawing of longitudinal horizontal section of problematic gland, in thirteenth segment under the low-powered objective.

Fig. 7.—Part of problematic gland from thirteenth segment, under the high-powered objective.

Fig. 8.—Tranverse section of the spermiducal gland, to show main duct.

Fig. 9.—Diagram of longitudinal vertical section of spermiducal gland, to show mode of entrance of the vasa deferentia.

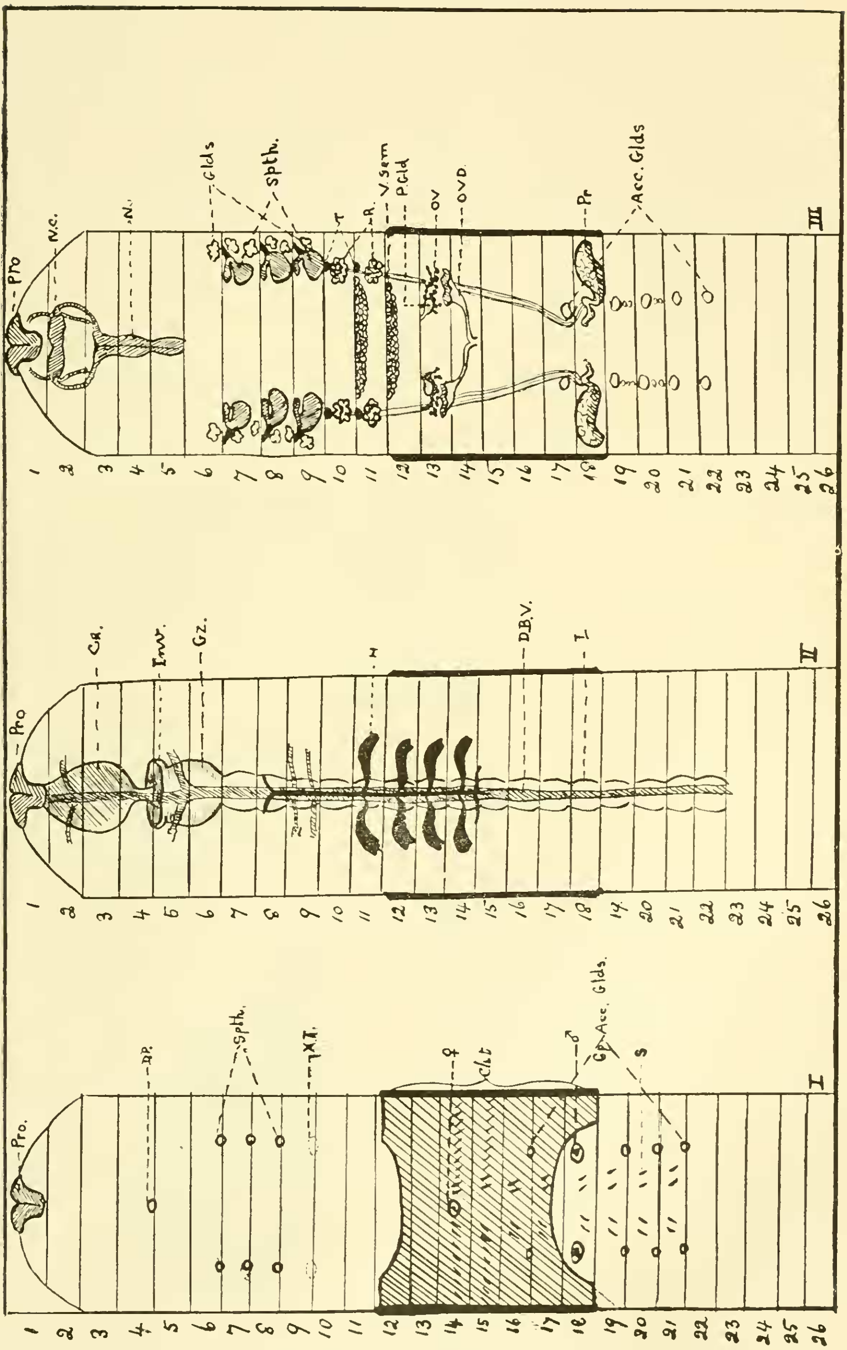
PLATE XXIX.

Fig. 1.—Longitudinal section of spermathecal region.

Fig. 2.—Drawing under the high-powered objective of the last part of the duct from a glandular structure associated with the spermathecae.

Fig. 3.—Drawing under the high-powered objective of a section through one of the glandular structures associated with the spermathecae.

Fig. 4.—Longitudinal section in the region of the possible nephridial organs.



Megascolex Fletcheri, n. sp.